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ABSORBENT ARTICLE WITH IMPROVED COMBINATION OF SKIN FEEL AND FLUID HANDLING

This is a continuation-in-part of application Serial No. 60/128,267, filed in the name of Walker, et al. on April 8, 1999, pending, which is a continuation-in-part of application Serial No. 08/832,715, filed in the name of Ouelette, et al. on April 11, 1997, pending, which is a continuation of application Serial No. 08/442,935, filed on May 31, 1995,abandoned, which is a continuation-in-part of application Serial No. 08/326,571, filed on October 20, 1994, abandoned, which is a continuation-in-part of application Serial No. 08/268,404, filed on June 30, 1994, abandoned.

FIELD OF THE INVENTION

The present invention relates to absorbent articles such as sanitary napkins, panty liners, diapers, adult incontinence pads and briefs, and the like having an improved combination of skin feel and fluid handling properties, such as fluid acquisition and retention.

BACKGROUND OF THE INVENTION

Absorbent articles such as diapers, sanitary napkins, panty liners, incontinence pads and briefs, tampons, and the like are well known and widely used to absorb bodily exudates such as urine, feces, and menses. Typical disposable absorbent articles often comprise a liquid pervious body side liner and an underlying absorbent core. The absorbent core may be sandwiched between the body side liner and a liquid impervious backsheet, which backsheet serves to protect garments and skin from contact with absorbed bodily discharges. Typically body side liners may comprise a topsheet such as an apertured formed film or a nonwoven topsheet layer. A body side liner may also comprise a multiple layer structure such as a topsheet in liquid communication with a secondary topsheet (which is also sometimes referred to as a distribution layer, surge management layer, wicking layer, or similar term).

In order to meet the fluid handling needs of a user, such absorbent articles need to rapidly remove deposited bodily exudates from the body-contacting surface of the absorbent article (acquisition) and retain such acquired fluids away from the body surface (retention or rewet prevention). Typically, the fluid handling performance of an absorbent article represents a balance between acquisition requirements and fluid retention requirements (rewet prevention). In general, the properties of the core and the topsheet interact to determine the balance.

Users of absorbent articles have other needs that also must be met to the greatest degree possible. For example, the body-contacting surface of the absorbent article should be as skin friendly as possible. Skin friendliness includes properties such as softness, compressibility, not retaining fluid adjacent to the skin, contains no irritating components, not occluding the skin so as to cause a hot, sweaty feel. For users of catamenial products, it is also important that menses that has been absorbed by the core be hidden from view as much as possible (masking). Properties of this type, while there is some performance requirement for the core, depend more on the performance of the topsheet.

The core of the typical absorbent article described above has two basic requirements: to drain the topsheet of deposited fluids and draw these fluids into the absorbent core for storage, and to resist subsequent release of previously absorbed fluid as a result of pressure exerted on the core or article as a whole (i.e. avoid "squeeze out" of the core which can cause rewet of the body surface). Other considerations, such as the overall capacity of the absorbent core, its thickness, and its stiffness are also important with respect to the design of superior absorbent articles.

A wide variety of fibrous web structures suitable for use as core components are known in the art, and many of these have attempted to provide high capillary pressure and other desirable properties. For example, US Patents 5,009,650 and 4,699,619 both issued to Bernardin. The Bernardin devices incorporate a layer of primarily softwood pulp fiber overlaying a layer of primarily hardwood pulp fiber. The Bernardin device, however, does not achieve the benefits of high capillary pressure and fluid retention demonstrated by the present invention. Additionally, the Bernardin device fails to incorporate superabsorbent particles throughout the layer. The use of bicomponent fibers for improved retention properties is also not described.

The topsheet of absorbent articles preferably allows deposited fluids to quickly penetrate the surface thereof (i.e. the topsheet should exhibit high liquid strike-through). Additionally, once fluids penetrate the topsheet, they should not flow back to the surface of the liner (i.e. the topsheet should inhibit rewet). Preferred topsheets are also as soft, comfortable, and as non-irritating to the skin of the user as possible.

The art has continually attempted to improve topsheet properties to address such needs. For example, one prior art approach has been to utilize a topsheet which comprises a web of formed, apertured thermoplastic film. Commonly assigned US Patent 4,342,314, issued to Radel et al. on August 3, 1982, the disclosure of which is hereby incorporated herein by reference, discloses a representative formed film of this variety. Such webs utilize capillary fluid transport to conduct fluid away from one surface (wearer-contacting) into and through the web via three-dimensional capillaries formed in the material, and then into the underlying absorbent structure. In order to address consumer concerns with regard to plastic-like appearance and feel, apertured, formed thermoplastic film webs have been developed which further include microscopic surface texturing (microtexture) and/or microscopic apertures (microapertures) to further enhance the visual and tactile impression of such webs. Representative film webs of this variety are discloses in commonly assigned US Patents 4,463,045, issued to Ahr et al. on July 31, 1984, and 4,629,643, issued December 16, 1986 to Curro et al., the disclosures of which are hereby incorporated herein by reference. While such formed film topsheets have enjoyed wide commercial success, many users still perceive them as being plastic-like and not particularly soft.

Another prior art approach is the use of nonwoven webs as a topsheet material. For example, nonwoven materials said to have desirable skin feel benefits compared to the aforementioned formed film topsheet materials are described in laid open Japanese Patent Application 7-119012, published in the name of Kao Corp. on May 9, 1995. While the fibrous nature of such nonwoven topsheets may have some desirable skin feel benefits, nonwoven materials are widely known to be deficient in preventing rewet.

One approach to combining the benefits of formed film materials and nonwoven materials has been to utilize a fibrous material as an overlay or laminate over a formed film. Representative topsheet structures of this variety are disclosed in Statutory Invention Registration H1670 published in the name of Aziz et al. on July 1, 1997, which describes nonwoven materials which overlay a formed film material; and in US Patent Application Serial No. 08/744,892, filed in the name of Sugahara on November 8, 1996 and published as WO 93/09744 on May 27, 1993, which describes a structure having a central region comprising a formed film and laterally outboard regions where a nonwoven material overlies the formed film; the disclosure of each of which is hereby incorporated herein by reference. In addition to transport through the formed film, webs of this variety also exhibit capillary fluid transport characteristics via the three-dimensional capillaries formed by inter-fiber spaces, likewise conducting fluid away from the wearer-contacting surface and toward the underlying absorbent structure. Such webs can exhibit an aesthetically-pleasing, cloth-like surface appearance and tactile impression due to the fibrous

nature of the surface. However, as will be recognized, such webs are much more expensive than a topsheet comprising a unitary material both because of the additional material used to produce the laminated web and the additional processing steps required for the production. Further, such webs may still be deficient in fluid handling because fluids can "hang up" in small inter fiber capillaries of the nonwoven portion so they remain near the body contacting surface.

The art has also attempted to provide fluid handling benefits of the three dimensional capillaries discussed above while reducing the plastic-like feel of such formed films using apertured (not formed) film that is bonded to an underlying nonwoven layer in a manner so as to provide a series of raised peaks that are separated by valleys. Such structures are described in US Patent 5,536,555, issued in the name of Zelazoski, et al. on July 16, 1996 and in PCT application Serial No. WO 97/02133, published in the name of Kimberly-Clark Corporation on January 23, 1997. While such structures may reduce the area of contact between the topsheet material and a wearer's body, a film material still contacts the wearer with the resulting plastic-like feel. Such materials also have the cost disadvantages of laminated materials discussed above.

US Patent 5,643,240, issued to Jackson, et al. on July 1, 1997 describes body side liners (topsheets) for absorbent articles that have a multi-layer structure with an apertured film layer superposed over a nonwoven web where the film layer and the nonwoven web have properties, such that when the layers are used in combination, an absorbent article using such a body side layer is said to have a good penetration rate and good rewet. However, when the claimed penetration rate and rewet values for the claimed absorbent article are compared to the values for the prior art absorbent article having a formed film topsheet that is described in the examples of the reference, the performance of the prior art article and the claimed article are very similar. Also, since the body contacting surface of the '240 patent is a formed film the body feel deficiencies of formed films discussed above would also be present.

Thus there is a continuing need for improved absorbent articles that combine improved fluid handling characteristics with improved body feel. As noted above, the desired characteristics of the topsheet and the absorbent core are related. For example, a core which exhibits a high capillary pressure capability will also have an increased tendency to drain fluids from the topsheet, thus assisting the topsheet in inhibiting rewet. Consequently, the design of an overall absorbent article may involve several tradeoffs in design considerations. For example, absorbent cores having high capillary pressure and topsheets having an improved balance of skin feel and fluid handling performance can be combined as described herein. In other words, by utilizing a core of the present invention and the topsheets of the present invention, absorbent articles having both improved skin feel and fluid handling properties are envisioned.

SUMMARY OF THE INVENTION

The present invention relates to absorbent articles such as sanitary napkins, panty liners, diapers, adult incontinence pads and briefs, and the like having an improved combination of skin feel and fluid handling properties, such as fluid acquisition and retention. Such improved properties are achieved by combining improved cores with improved topsheets. Particularly preferred embodiments of the present invention have a Drop Acquisition Time less than about 35 seconds, a Strikethrough Time less than about 55 seconds, a Wetback of less than 30 milligrams, and a panel softness score of between 30 and 60 PSU. These properties are provided by combining improved absorbent core structures with topsheet designs having improved skin feel and fluid handling properties.

In one preferred embodiment of the present invention, the improved cores comprise a multiplicity of hardwood pulp fibers, a multiplicity of softwood pulp fibers, and superabsorbent particles. Both fiber types and the superabsorbent particles are present in a substantially uniform admixture throughout the web which is an airlaid web structure. The hardwood pulp fibers may preferably comprise eucalyptus fibers, which eucalyptus fibers are preferably from about 10% to about 50% by weight of the web. The softwood pulp fibers may preferably comprise southern softwood kraft fibers, which fibers are preferably from about 20% to about 60% by weight of the web. Alternatively, the pulp fibers may also be combined with bicomponent thermoplastic fibers.

Preferred topsheets according to the present invention have improved skin feel with excellent fluid handling properties. The topsheets are fluid permeable but provide a barrier to rewet. The topsheets according to the present invention also preferably have a multiplicity of fibrils that project above the underlying surface of the topsheet material where the fibrils originate which produces a soft, velutinous surface.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of a preferred embodiment of an absorbent article in the form of a sanitary napkin which includes an absorbent core and topsheet according to the present invention.

Figure 2 is a cross-sectional view along line 2–2, of the preferred embodiment of the present invention shown in Figure 1.

Figure 3 is a cross-sectional view along line 3–3, of the preferred embodiment of the present invention shown in Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

The Absorbent Article

The present invention relates to absorbent articles having an improved combination of surface feel and fluid handling properties. The absorbent articles, such as sanitary napkins, diapers, adult incontinence pads and briefs, panty liners, and the like, as are described herein, generally comprise three basic structural components. One such component is a substantially liquid impervious backsheet. On top of this backsheet is disposed an absorbent core such as any of the structures of the present invention described herein. On top of this absorbent core and joined to the backsheet at least about the periphery of the absorbent article is a fluid pervious topsheet. Optionally, at least one acquisition component (also sometimes referred to as a fluid distribution layer), may be located between the topsheet and the absorbent core.

The present invention uses novel combinations of topsheets and absorbent cores to provide absorbent articles having the aforementioned improved combination of fluid handling and surface feel. Prior art absorbent articles have been able to provide either, but not both of these properties in one article. In particular, the absorbent articles of the present invention have rapid fluid acquisition (low strikethrough and drop acquisition times) and low rewet (low wetback amount) in combination with excellent softness. Example 1 below compares the fluid handling properties and softness of several embodiments of the present invention with exemplary prior art absorbent articles. These examples clearly demonstrate the improved performance of the absorbent articles of the present invention.

As noted above, the absorbent articles of the present invention generally provide rapid acquisition of bodily fluids that are deposited thereon. While fluid acquisition may be evaluated in many ways using a variety of test fluids, the methods for Drop Acquisition Time and Liquid Strike-Through Time, given in the ANALYTICAL METHODS section below, are believed to provide useful information about an absorbent article's ability to rapidly acquire bodily fluids. Both methods determine the time required for a sample to acquire a controlled volume of fluid that is rapidly deposited on the body surface of the sample. As such, a suitable absorbent article according to the present invention has a Drop Acquisition Time of less than about 35 seconds, preferably less than about 30 seconds, more preferably 25 seconds, still more preferably less than about 20 seconds, and most preferred less than about 15 seconds. Similarly, a suitable absorbent article according to the present invention will have a Liquid Strike-Through Time of less than about 60 seconds, preferably less than about 55 seconds, and more preferably less than about 50 seconds.

Absorbent articles according to the present invention also inhibit absorbed bodily fluids from moving from the interior of the absorbent article back to the body surface thereof when the absorbent article is exposed to forces due to wearer movement so as to minimize rewet. The

Wetback Test described in the ANALYTICAL METHODS section below is a laboratory measure of rewet. The test describes a method that determines the amount of absorbed test fluid that returns to the surface of a sample after it has absorbed a controlled amount of fluid and is then loaded with a controlled pressure. When evaluated according to this method a suitable absorbent article according to the present invention has a Wetback of less than about 40 milligrams, preferably less than 30 milligrams, more preferably less than 20 milligrams.

The absorbent articles of the present invention also have a desirable skin feel. While not being bound by theory, it is believed that the primary contributor to the skin feel of the absorbent articles of the present invention is the interaction between a wearer's skin and the body surface of the absorbent article. As is discussed in detail below, it is believed that the body surface has a soft, velutinous texture due to a multiplicity of fibrils that project above underlying structure of the topsheet material and a compressible, low density body-contacting surface.

While the present invention is suitable for all types of absorbent articles, including baby diapers and adult incontinence products, it will be illustrated in a particularly preferred embodiment, a catamenial pad, sanitary napkin 20, shown in Figure 1. As used herein, the term "sanitary napkin" refers to an absorbent article which is worn by females adjacent to the pudendal region, generally external to the urogenital region, and which is intended to absorb and contain menstrual fluids and other vaginal discharges from the wearer's body (e.g., blood, menses, and urine). Interlabial devices which reside partially within and partially external of the wearer's vestibule are also within the scope of this invention. As used herein, the term "pudendal" refers to the externally visible female genitalia. It should be understood, however, that the present invention is also applicable to other feminine hygiene or catamenial pads such as pantiliners, or other absorbent articles such as incontinence pads, tampons, and the like.

Figure 1 is a plan view of the sanitary napkin 20 of the present invention in its flat-out state with portions of the structure being cut-away to more clearly show the construction of the sanitary napkin 20. The portion of the sanitary napkin 20 which faces or contacts the wearer 20A is oriented towards the viewer. As shown in Figure 1, the sanitary napkin 20 preferably comprises a liquid pervious topsheet 21, a liquid impervious backsheet 23 joined with the topsheet 21, and an absorbent core 25 of the present invention positioned between the topsheet 21 and the backsheet 23. The sanitary napkin 20 depicted in Figure 1 is a simplified absorbent article that could represent a sanitary napkin prior to its being placed on a wearer's undergarment. It should be understood, however, that the present invention is not limited to the particular type or configuration of sanitary napkin shown in Figure 1.

The sanitary napkin 20 has two surfaces, a body-contacting surface or "body surface" 20A and a garment surface. The sanitary napkin 20 is shown in Figure 1 as viewed from its body surface. The body surface is intended to be worn adjacent to the body of the wearer while the garment surface is on the opposite side and is intended to be placed adjacent to the wearer's undergarments when the sanitary napkin 20 is worn.

The sanitary napkin 20 has two centerlines, a longitudinal centerline "L" and a transverse centerline "T". The term "longitudinal", as used herein, refers to a line, axis or direction in the plane of the sanitary napkin 20 that is generally aligned with (e.g., approximately parallel to) a vertical plane which bisects a standing wearer into left and right body halves when the sanitary napkin 20 is worn. The terms "transverse" or "lateral" as used herein, are interchangeable, and refer to a line, axis or direction which lies within the plane of the sanitary napkin 20 that is generally perpendicular to the longitudinal direction.

Figure 1 also shows that the sanitary napkin 20 has a periphery 30 which is defined by the outer edges of the sanitary napkin 20 in which the longitudinal edges (or "side edges") are designated 26 and the end edges (or "ends") are designated 28. In the embodiment depicted in Figure 1, the sanitary napkin 20 is preferably symmetrical with respect to both the longitudinal and transverse centerlines although asymmetry about one of the centerlines is within the scope of the invention. Sanitary napkin 20 preferably includes side flaps or "wings" 34 that are folded around the crotch portion of the wearer's panties. The side flaps 34 can serve a number of purposes, including, but not limited to, protecting the wearer's panties from soiling and keeping the sanitary napkin secured to the wearer's panties. While the topsheet, the backsheet, and the absorbent core may be assembled in a variety of well known configurations (including so called "tube" products or side flap products), preferred sanitary napkin configurations are described generally in US Patent No. 4,950,264, issued to Osborn on Aug. 21, 1990; US Patent No. 4,425,130, issued to DesMarais on Jan. 10, 1984; US Patent No. 4,321,924, issued to Ahr on Mar. 30, 1982; US Patent No. 4,589,876, issued to Van Tilburg on Aug. 18, 1987.

Figure 1 shows a preferred embodiment of the sanitary napkin 20 in which the topsheet 21 and the backsheet 23 have length and width dimensions generally larger than those of the absorbent core 25. The topsheet 21 and the backsheet 23 extend beyond the edges of the absorbent core 25 to thereby form not only portions of the periphery but also side flaps. As best seen from Figure 1, the backsheet 23 and the topsheet 21 are positioned adjacent the garment surface and the body surface, respectively, of sanitary napkin 20 and are preferably joined to each other to form a perimeter 30. For example, the backsheet 23 and the topsheet 21 can be secured to each other by a uniform continuous layer of adhesive, a patterned layer of adhesive, or an array of

separate lines, spirals, or spots of adhesive. Adhesives that have been found to be satisfactory are manufactured by H. B. Fuller Company of St. Paul, MN under the designation HL-1258 or H-2031. Alternatively, topsheet 21 and backsheet 23 can be joined to each other by heat bonding, pressure bonding, ultrasonic bonding, dynamic mechanical bonding, or any other suitable method for joining topsheets and backsheets known in the art.

Figures 1–3 show the individual components of the main body portion 22 of the sanitary napkin 20 of the present invention. The main body portion 22 of the sanitary napkin comprises at least three primary components. These include a liquid pervious topsheet 38, a liquid impervious backsheet 40, and absorbent core 42 positioned between the topsheet 38 and the backsheet 40. Preferably, the main body portion 22 of the sanitary napkin 20 also comprises at least one optional acquisition component 44. The acquisition component 44 may either be a separate component positioned between the topsheet 38 and the absorbent core 42, or it may comprise part of a composite topsheet or part of the absorbent core 42.

<u>The Topsheet</u>

The topsheet 38 is a liquid pervious component that permits liquids (e.g., menses and/or urine) to readily penetrate through its thickness. The topsheet 38 is preferably compliant, soft feeling, and non-irritating to the wearer's skin. As noted above, preferred topsheets according to the present invention have both excellent skin feel and fluid handling properties

In preferred embodiments of the present invention, at least a portion of the body surface of the topsheet 38 is hydrophilic so that liquids will be transferred through the topsheet more readily. This diminishes the likelihood that bodily fluids will flow off the topsheet rather than flowing into and being absorbed by the absorbent core 42. The body surface of the topsheet 38 can be made hydrophilic by treating it with a surfactant. Suitable methods of treating a topsheet with a surfactant are described in US Patent 4,950,254 issued to Osborn and in US Patent 5,520,875, issued to Wnuk, et al. on May 28, 1996. Particularly preferred surfactant materials are described in copending, commonly assigned US Patent application Serial No. 09/287,986, filed in the name of Stone on April 8, 1999.

Preferred topsheets 38 according to the present invention achieve their desirable balance of skin feel and fluid handling properties by having means so bodily fluids that are deposited on the body surface 20A of sanitary napkin 20 rapidly pass through the topsheet 38 for absorption by the absorbent core 42. Such preferred topsheets also provide a barrier that inhibits such absorbed fluids from moving in the opposite direction when the sanitary napkin 20 is exposed to forces due to wearer movement so as to minimize rewet. The topsheet also has desirable skin feel properties

as are provided by a multiplicity of fibrils that project above the underlying structure of the topsheet material where the fibrils originate so as to provide a substantially uniform soft and silky skin feel.

A suitable topsheet 38 may be manufactured from a wide range of materials such as woven and nonwoven materials; polymeric materials such as apertured formed thermoplastic films, apertured plastic films, and hydroformed thermoplastic films; porous foams; reticulated foams; reticulated thermoplastic films; and thermoplastic scrims. Suitable woven and nonwoven materials can be comprised of synthetic fibers (e.g., polymeric fibers such as polyester, polypropylene, or polyethylene fibers). Such suitable topsheets may also be composite structures comprising both a formed thermoplastic film layer and a fibrous layer or two thermoplastic film layers that are subsequently formed.

As noted above, such preferred topsheets 38 are liquid permeable so as to provide rapid strikethrough of deposited bodily fluids for absorption by the core 42. One means of achieving rapid strikethrough is to provide a multiplicity of apertures through the topsheet. Such apertured topsheets are described in greater detail in the aforementioned US Patent application Serial No. 08/832,715, which describes formed films having microscopic spaced apart depositions of a low surface energy material thereon and in US Patent application Serial No. 09/217,736 filed in the names of Curro, et al. on December 21, 1998, which describes a laminate of an apertured nonwoven and a formed apertured thermoplastic film. Preferably, the body contacting surface is provided with a plurality of microscopic, discontinuous, spaced regions that comprise depositions of a low surface energy material. The depositions have a surface energy that is lower than the surface energy of the underlying polymeric substrate which creates a surface energy gradient between the depositions and the underlying substrate. This surface energy gradient exerts a force on fluid contacting the body contacting surface of the topsheet to direct to direct fluids away from the body contacting surface and through the topsheet for absorption by the core 42. Such surface depositions are described in greater detail in US Patent 6,025,049 issued in the names of Ouelette, et al. on February 15, 2000.

While a topsheet 38 may have rapid strikethrough (i.e. rapid movement of fluid from the body surface 20A of the sanitary napkin 20 to the core 42), it is also important for purposes of the present invention that a suitable topsheet 38 also inhibit rewet of such acquired fluids. As is well known, wearer movement applies forces to absorbent articles that can cause fluid movement from the core toward the body surface of the article which can cause the fluids to rewet the body surface. Rewet can be inhibited by providing a barrier to such reverse fluid flow toward the body surface. Such a barrier can have many forms. For example, the structures described in the

aforementioned US Patent 4,342,314 use capillary size to partially inhibit reverse fluid flow. In addition, the formed film webs disclosed therein are somewhat resistant to the shear forces caused by bodily movement and provide some separation between the body surface and the top of the absorbent core. Another means of inhibiting rewet is to provide a surface chemical barrier to reverse fluid flow. The surface energy gradients disclosed in the aforementioned US Patent 6,025,049 and in the aforementioned US Patent application Serial No. 08/832,715 are believed to provide such a surface chemical barrier to rewet.

In addition to the fluid handling properties discussed above the topsheets of the present invention have desirable skin feel. As noted above, it is believed that such desirable skin feel is due to the presence of a multiplicity of fibrils that project above the underlying surface of the topsheet material where the fibrils originate. Such fibrils produce a soft, velutinous surface which contacts the wearer's body and enhances the skin feel of the topsheet. Depending on the structure of the topsheet 38, such fibrils can comprise the microapertures discussed in the aforementioned US Patent 6,025,049 or the portion of the fibers of a nonwoven structure that may extend above the bulk of the structure.

This softness is readily perceivable by tactile evaluation. As can clearly be seen in Examples 1 and 2, when topsheets 38 according to the present invention are evaluated for softness using the Panel Softness method given in the ANALYTICAL METHODS section below, graders rate the topsheets 38 of the present invention very highly. Suitably, an absorbent article using a topsheet 38 according to the present invention has a softness rating of between about 30 panel score units (PSU) and about 60 PSU. Preferably, the softness rating is between about 35 PSU and about 60 PSU. More preferably, the softness is between about 40 PSU and about 60 PSU.

The fibrils provide a compressibility to the body surface 20A of the sanitary napkin 20 because they project above the underlying surface of the topsheet material. As will be recognized such compressibility depends both on the dimensions of the individual fibrils and the mechanical properties of the fibrils. The Thickness Under Load Test described in the ANALYTICAL METHODS section below evaluates both of these contributors to provide an overall response that relates to this aspect of body feel. As can be seen therein this method measures the force necessary to compress a sample by the approximate length of the fibrils. Thus, samples having a low compressibility value are believed to be particularly preferred because of their "cushy" feel. Exemplary compressibility data are given in Example 2 which compares topsheets according to the present invention with various prior art topsheets. Suitably, a topsheet according to the present

invention has a compressibility less than about 400 grams/cm^3. Preferably, the compressibility is less than about 375 grams/cm^3; more preferably, less than about 350 grams/cm^3.

This compressibility is believed to be due to a region of the topsheet that is defined by the volume that lies between the underlying surface of the topsheet material and the distal ends of the fibrils. As will be recognized, because this region is occupied only by the material comprising the fibrils, the region has a low density. A method for determining this surface density is given in the Thickness Under Load method that is described in the ANALYTICAL METHODS section below. The reason the compressibility of this region is low is that the only material resisting compression is the material that comprises the fibrils. As compression continues so as to bring the fibrils into closer contact such that the density in the region begins to approach the density of the underlying topsheet material, the compressive force must, of necessity increase. It has been found that a material having a Surface Density that is less than about 0.035 grams/cubic centimeter has desirable softness. Preferably, the Surface Density is less than 0.03 about grams/cubic centimeter.

The fibrils that provide such desirable surface feel to topsheets according to the present invention can be provided using various means. Suitable means include: hydroforming as described in the aforementioned US Patent 4,629,643; body surfaces comprising a nonwoven material as disclosed in the aforementioned US Patent application Serial No. 08/832,715; napping and separation of softened polymeric material from a template as disclosed in PCT application Serial No. WO 99/06623 published in the name of Minnesota Mining and Manufacturing company on February 11, 1999; printing a hot melt material on the body surface as described in commonly assigned US Patent 5,763,044, issued to Ahr, et al on June 9, 1998; brushing; and other means as would be known to those having skill in the art.

Topsheets 38 having the particularly preferred combination of fluid handling and skin feel include: the formed thermoplastic film materials having a plurality of macroapertures and a multiplicity of microapertures wherein land area between the microapertures and the macroapertures is also provided with a plurality of microscopic, discontinuous, spaced regions that comprise depositions of a low surface energy material. Such a structure creates a surface energy gradient between the depositions and the underlying polymeric structure of the formed film as described in the aforementioned US Patent 6,025,049; the nonwoven materials having depositions of a low surface energy material that create a surface energy gradient between the depositions and the underlying polymeric structure of the nonwoven material as described in US Patent application Serial No. 08/832,715 filed in the names of Ouelette, et al. on April 11, 1997 and in US Patent 5,792,404, issued to Cree, et al. on August 11, 1998. The disclosure of each of which is incorporated herein by reference.

Other suitable materials for use as the topsheet 38 include the nonwoven materials provided with apertures according to US Patent, 5,628,097, issued in the name of Benson, et al. on May 13, 1997; the laminate of a nonwoven material and a formed apertured thermoplastic film, the nonwoven material having depositions of a low surface energy material that create a surface energy gradient between the depositions and the underlying polymeric structure of the nonwoven material as described in US Patent application Serial No. 08/761,905 filed in the name of Bien on December 5, 1996 and in the aforementioned US Patent application Serial No. 09/217,736; the permanently hydrophilic formed film materials described in US Patent application Serial No. 09/344,161, filed in the name of Lee, et al. on June 24, 1999; and in the textured, microapertured polymeric film webs that are described in US Patent application Serial No._______ and the apertured polymeric webs having a multiplicity of three dimensional surface structures as described in US Patent application Serial No._______, both filed in the name of Lee, et al. on April 7, 2000 (P&G Case Nos. 8011 and 8012 respectively; the Applicant will add the filing information when it is known). The disclosure of each of which is incorporated herein by reference.

The Backsheet

The backsheet 40 prevents the exudates absorbed and contained in the absorbent core 42 from wetting articles which contact the sanitary napkin 20 such as pants, pajamas and undergarments. The backsheet 40 is preferably resistant to the flow of liquids, and more preferably is impervious to liquids (e.g., menses and/or urine). The backsheet 40 is preferably manufactured from a flexible material. As used herein, the term "flexible" refers to materials which are compliant and will readily conform to the general shape and contours of the human body. The backsheet 40 may comprise a woven or nonwoven material, polymeric films such as thermoplastic films of polyethylene or polypropylene, or composite materials such as a film-coated nonwoven material. Preferably, the backsheet 40 is a polyethylene film having a thickness of from about 0.012 mm (0.5 mil) to about 0.051 mm (2.0 mils). The backsheet 40 may be embossed and/or matte finished to provide a more clothlike appearance. Further, the backsheet 40 may permit vapors to escape from the absorbent core 42 (i.e., breathable) while still preventing exudates from passing through the backsheet 40. A suitable backsheet material is obtained as product No. 18-1401 from the Clopay Corporation of Cincinnati, OH. A suitable breathable backsheet material is a laminate of an apertured film such as that described in US Patent 3,929,135 issued to Thompson which is inverted so that the smaller openings of the tapered capillaries face the absorbent core 42 which is adhesively laminated to a microporous film such as that described in Exxon's US Patent 4,777,073.

The Absorbent Core

The absorbent core 42 may be any absorbent means which is capable of absorbing and retaining liquids (e.g., menses and/or urine). A suitable core for purposes of the present invention has a high affinity for such liquids. Because of this high affinity, the absorbent core 42 is particularly effective in drawing such liquids from the topsheet 38 and in retaining such acquired liquids. Suitable structures for the core 42 have a high capillary pressure which allows the core 42 to effectively draw liquids that are deposited on the body surface 20A of sanitary napkin 20 through the topsheet 38 for storage. Suitable core structures also retain fluids well either because of a high capillary desorption pressure or because the core structure also comprises a superabsorbent material which can store acquired fluids by osmotic means.

As noted above, cores 42 of the present invention, because of their high capillary absorption pressure, can more fully dry the topsheet 38 than cores with a lower capillary absorption pressure. A method for measuring absorption pressure is provided in the ANALYTICAL METHODS section below. Because the cores 42 have a particularly high absorption pressure, they are very effective in acquiring fluids that are deposited on the topsheet 38. Suitably the mean absorption pressure is at least about 7 cm. Preferably, the mean absorption pressure is at least about 10 cm; more preferably, at least about 12 cm. Typically, the mean absorption pressure is between about 7 cm and about 25 cm. More typically, the mean absorption pressure is between about 10 cm and about 25 cm.

The absorbent core 42 may be manufactured in a wide variety of sizes and shapes (e.g., rectangular, oval, hourglass, dog bone, asymmetric, etc.). The configuration and construction of the absorbent core 42 may also be varied (e.g., the absorbent core may have varying caliper zones (e.g., profiled so as to be thicker in the center), or may comprise one or more layers or structures. The total absorbent capacity of the absorbent core should, however, be compatible with the design loading and the intended use of the sanitary napkin. Further, the size and absorbent capacity of the absorbent core may be varied to accommodate different uses such as incontinence pads, pantiliners, regular sanitary napkins, or overnight sanitary napkins.

A wide variety of liquid-absorbent materials commonly used in sanitary napkins and other absorbent articles are suitable for manufacture of the absorbent core 42, such as blends comprising comminuted wood pulp which is generally referred to as airfelt. Examples of other suitable absorbent materials meltblown polymers including coform; chemically stiffened, modified or cross-linked cellulosic fibers; synthetic fibers such as crimped polyester fibers; peat moss; tissue including tissue wraps and tissue laminates; absorbent foams; absorbent sponges;

superabsorbent polymers; absorbent gelling materials; or any equivalent material or combinations of materials, or mixtures of these. The configuration and construction of the absorbent core may also be varied (e.g., the absorbent core may have varying caliper zones (e.g., profiled so as to be thicker in the center), hydrophilic gradients, superabsorbent gradients, or lower density and lower average basis weight acquisition zones; or may comprise one or more layers or structures).

A particularly preferred absorbent core 42 according to the present invention utilizes a combination of hardwood pulp fibers and softwood pulp fibers in an airlaid fibrous web. The incorporation of the hardwood fibers in the combinations described allows for increased capillary pressure and improved fluid distribution compared to absorbent webs without such fiber content. Additionally, by making the structure an airlaid structure, it is possible to incorporate superabsorbent particulate material throughout the core 42 and to achieve improved stiffness control over the resulting core as compared to the prior art. Consequently, the absorbent core 42 of the present invention is particularly well suited for use with the above-described topsheet materials due to its high capillary pressure, its high capacity through the use of superabsorbent material, and its high control over stiffness and other physical properties.

The particularly preferred absorbent core 42 of the present invention is an airlaid fibrous web comprising a substantially uniform admixture of hardwood pulp fibers and softwood pulp fibers. Preferably, the fibrous absorbent web also incorporates superabsorbent particles throughout the web. Additionally, the fibrous web layer may also incorporate synthetic fibers, such as bicomponent binder fibers, in the uniform admixture of fibers described above.

Unless otherwise noted, all composition percentages given below are expressed in terms of weights of the quantities being considered. Preferably, the fibrous absorbent web 40 of the present invention includes a ratio of softwood pulp fibers to hardwood pulp fibers in the range of from about 4:1 to about 1:2, more preferably from about 3:1 to about 1:1, most preferably about 2:1. A particularly preferred hardwood pulp fiber is a eucalyptus fiber. A particularly suitable eucalyptus fiber includes those of the eucalyptus grandis species. The hardwood pulp fibers, and eucalyptus in particular, have high surface area, thereby providing the absorbent web with a high capillary pressure. Too much hardwood pulp fiber, however, in the web will reduce its overall absorbent capacity. Additionally, the presence of excess hardwood pulp fiber may lower the fluid handling speed of the web to an unacceptably low level. Other suitable pulp fibers for use as a hardwood fiber in the absorbent core 42 of the present invention may include acacia, oak, maple, or cherry fibers.

The hardwood pulp fibers are blended in the absorbent core 42 with a multiplicity of softwood pulp fibers. The softwood pulp fibers are preferably blended into the structure in the ratios indicated above. A particularly preferred softwood pulp fiber is southern softwood kraft fibers. Other suitable softwood fibers include western and northern softwood kraft fibers.

The blend of hardwood pulp fibers and softwood pulp fibers provides a web with different sized fibers incorporated throughout. This provides a good distribution of fiber surface area and provides, in preferred embodiments, a high overall surface area. As noted above, the use of hardwood fibers involves tradeoffs between capillary pressure, and capacity and/or fluid handling speed. Because the cores 42 of the present invention are airlaid, they are readily amenable to the inclusion of a superabsorbent material. Such superabsorbent material will improve the overall capacity of the core 42, thereby advantageously combining high capacity and high capillary pressure.

The preferred absorbent core 42 of the present invention preferably also incorporates bicomponent binder fibers and/or superabsorbent particles. In more preferred embodiments, both the bicomponent fibers and the superabsorbent particles are present in the web and are blended in a substantially uniform mixture throughout the web thickness.

As will be recognized, the addition of bicomponent fibers allows for thermal bonding processes, such as through air bonding, bonding using heated rolls, ultrasonic bonding, and other means wherein a bonding material is melted. Such bonding also enables positive stiffness control of the overall layer. The stiffness of the web is controlled by adjusting the amount of bicomponent fiber as well as the time and temperature parameters of the thermal bonding process. Suitably, between about 5% and about 30% of the web is bicomponent fibers. In a particularly preferred embodiment, between about 15% and about 25% of the web is bicomponent fibers. A preferred fiber comprises a polyethylene/polypropylene fiber in which the polypropylene core is surrounded by a polyethylene sheath Such a suitable 50%/50% concentric bicomponent fiber is available from Danaklon of Varde, Denmark.

Other binder materials may be included within the web structure as well. Polyethylene powder binders and/or latex binder material may be, but need not be, incorporated into the web structure. The use of a powder binder such as polyethylene allows the web to be a thermally bonded structure as is the case with the bicomponent binder fibers described above. If latex, or a similar binder is used, the latex will act as the binder and the structure may be described as "latex bonded."

While the foregoing discussion indicates how the components of the fibrous portion of the particularly preferred core structure interact to provide high capillary pressure, other components of the absorbent core 42 can also contribute to the performance thereof. Specifically, as noted above, the use of superabsorbent materials in the cores 42 of the present invention is preferred. An exemplary superabsorbent material is SAB 960, as is available from Stockhausen Louisiana Limited of Garyville, LA. Preferred superabsorbent particulate materials for use in the present invention have high permeability because and reduced gel blocking compared to commonly used superabsorbent materials. Exemplary preferred materials include surface crosslinked polyacrylates such as ASAP 2300 as is available from Chemdal, Corp. of Palatine, IL and the mixed bed materials described in copending, commonly assigned US Patent application Serial No. 09/258,890, filed in the names of Hird, et al. on March 1, 1999. The AGM particles preferably comprise from about 10% to about 50% of the absorbent core 42. A higher amount of such superabsorbent material increases the overall capacity of the absorbent core 42. Excess superabsorbent material, however, may reduce the permeability of the core 42 due to gel blocking or similar effects.

The fibrous absorbent web of the present invention may be made by any suitable airlaying technique known in the art. The use of airlaying allows the incorporate of particulate superabsorbent material throughout the structure, as well as greater positive control over the web physical properties than may be possible with other web forming techniques.

When the web incorporates bicomponent fibers, the web is preferably formed using a thermally bonded airlaid technique as described above. In such a construction, the use of additional binder material such as powder binder or latex is not required. Such additional materials may, nonetheless, be included in order to form a multi-bonded airlaid web. Additionally the web need not incorporate any bicomponent fiber, and may use latex in combination with the superabsorbent particles and hardwood and softwood pulp fibers as described above to form a latex bonded airlaid structure. Suitable methods of forming such airlaid structures are well known in the art. Another alternative includes the use of a powdered binder such as polyethylene together with a multiplicity of hardwood pulp and softwood pulp fibers to form a thermally bonded airlaid web.

U.S. Patent 5,445,777 describes a preferred method of adding a particulate superabsorbent material and/or a powdered binder material (such as the polyethylene binder described above) to a fibrous airlaid web. Such techniques are suitable for construction of the fibrous absorbent webs 40 of the present invention.

The airlaid structure of the present invention may be made with any suitable basis weight and density for the article in which is to be utilized. Suitably, the basis weight can be between about 60 g/m^2 and about 400 $g/m^2$and the density can be between about 0.05 g/cc and about 0.2 g/cc. A preferred structure for use in a sanitary napkin may have a total basis weight of about 200 g/m^2, a preferred density of about 0.13 g/cc, and a caliper of about 1.5 mm.

For thicker products, the absorbent core 42 of the present invention may comprise a fluff of hardwood pulp fibers and softwood pulp fibers wherein the caliper and basis weight are tailored to meet the needs of users who desire such products. Optionally, a superabsorbent material may be incorporated homogeneously throughout the structure.

An alternative preferred material for the absorbent core 42 comprises polymeric foams formed from high internal phase emulsions (HIPE foams) as are described in US Patent 5,795,921 issued in the name of Dyer, et al. on August 18, 1998. Such foam materials can be produced so as to have a suitably small cell size so as to provide the high capillary absorption pressure that is discussed above, yet have sufficient openness to allow free movement of the insoluble components in blood-based fluids such as menses. These absorbent foams are made by polymerizing HIPEs where the volume to weight ratio of the water phase to the oil phase is in the range of from about 20:1 to about 125:1.

In addition to the absorbent materials described above, the absorbent core 42 may comprise other types of absorbent materials known in the art such as, creped cellulose wadding; meltblown polymers including coform; chemically stiffened, modified or cross-linked cellulosic fibers; synthetic fibers such as crimped polyester fibers; peat moss; tissue including tissue wraps and tissue laminates; absorbent foams; absorbent sponges; or any equivalent material or combinations of materials, or mixtures of these. Such additional materials can either be in the form of additional layers as are discussed below with respect to the acquisition component 44 or can comprise alternative preferred structures for the absorbent core 42.

While such alternative preferred structures must still meet the fluid handling requirements for the absorbent core 42 discussed above, the structures provide the designer of an absorbent article with additional design flexibility to meet performance requirements other than those discussed herein while still providing absorbent articles having the overall desirable fluid handling and skin feel of the absorbent articles of the present invention. Exemplary core structures that are also suitable for purposes of the present invention include an acquisition component that is pattern bonded to the topsheet so as to create an unbonded window which overlies an absorbent core comprising a multi-bonded air laid nonwoven material comprising

a blend of cellulose fibers, bi-component fibers, superabsorbent particles, and latex binder as is described in commonly assigned and copending US Patent Application Serial No. 09/074,909 filed on May 8, 1998, in the name of Daniels et al. and in International Patent Application Serial No. PCT/US96/20873, filed on December 20, 1996, in the name of Lynard et al., which application designates the United States; and the blends of chemically stiffened, twisted, and curled bulking fibers, high surface area fibers, and thermoplastic binding fibers as described in US Patent 5,549,589 issued the name of Horney et al on August 27, 1996. The disclosure of each of which is incorporated herein by reference. Absorbent cores 42 may also comprise blends or combinations of fibrous materials and HIPE foams wherein the foam is either in sheet or particulate form.

The acquisition component (or "acquisition layer" or "distribution layer") 44, if used, lies beneath the topsheet 38. The terms "layer" or "web", as used herein, include but are not limited to single unfolded sheets, folded sheets, strips of material, loose or bonded fibers, multiple layers or laminates of material, or other combinations of such materials. These two terms are thus, not limited to single unfolded layers or sheets of material. The acquisition component 44 may provide void volume beneath the topsheet 38 to increase the ability of the sanitary napkin to draw liquids through the topsheet 38. In the preferred embodiment described herein, the acquisition component 44 preferably provides resiliency to lateral compressive forces so that the sanitary napkin 20 has improved resistance to bunching.

The acquisition layer serves to quickly collect and temporarily hold discharged bodily fluids, as well as facilitating transport of the fluid from the point of initial fluid contact to other parts of the acquisition layer and the absorbent core. There are several reasons why the improved transport of exudates is important, including providing a more even distribution of the exudates throughout the absorbent core and allowing the sanitary napkin 20 to be made relatively thin. The transport referred to herein may encompass the transportation of liquids in one, two or all directions (i.e., in the x-y plane and/or in the z-direction). The acquisition layer may be comprised of several different materials including nonwoven or woven webs of synthetic fibers including polyester, polypropylene, or polyethylene, natural fibers including cotton or cellulose, blends of such fibers, or any equivalent materials or combinations of materials. Examples of sanitary napkins having an acquisition layer and a topsheet are more fully described in US Patent No. 4,950,264 issued to Osborn, US Patent application Ser. No. 07/810,774, Dec. 17, 1991 filed in the names of Cree, et al. and published as PCT application Serial No. WO 93/117,725 on June 24, 1993, and the aforementioned International Patent Application Serial No. PCT/US96/20873. The disclosure of each of these references is incorporated herein by

reference. In a preferred embodiment, the acquisition layer may be joined with the topsheet by any of the conventional means for joining webs together, most preferably by fusion bonds as is more fully described in the above-referenced Cree application.

The acquisition component 44 should be liquid permeable. The acquisition component 44 is also preferably compliant, soft feeling, and non-irritating to the user's skin. The acquisition component 44 has a body-facing face (or side), and a garment-facing face. The acquisition component 44 may be of any suitable size and shape. In the embodiment shown in Figure 1, the acquisition component 44 is in the shape of a race track with slightly concave side edges, as is the portion of the topsheet 38 that overlies the main body portion 22 of the sanitary napkin 20. The dimensions of the acquisition component 44, however, are preferably not as large as those of the topsheet 38.

The acquisition component 44 can be made from any materials suitable for the above purposes that are capable of having the topsheet 38 fused to them. The acquisition component 44 may, for example, be comprised of woven or nonwoven materials. The fibers or other components of these materials may be synthetic, or partially synthetic and partially natural. Suitable synthetic fibers include polyester, polypropylene, polyethylene, nylon, viscous rayon, or cellulose acetate fibers. Suitable natural fibers include cotton, cellulose, or other natural fibers. The acquisition component 44 may also be at least partially comprised of cross-linked cellulose fibers. The acquisition component 44, if nonwoven, can be made by a number of different processes. These include, but are not limited to: air laid, wet laid, meltblown, spunbonded, carded, thermally bonded, air-through bonded, powder bonded, latex bonded, solvent bonded, spunlaced, and combinations of the foregoing.

The acquisition component 44 may be constructed in the manner described in the aforementioned US Patent 5,549,589 with respect to the distribution layer described therein. Another preferred construction for the acquisition component 44 is a laminate of two nonwoven materials. The uppermost layer of this laminate (or "secondary topsheet") 46 preferably comprises an 19 g/yd^2 (22.5 g/m^2) spunbonded polypropylene nonwoven material referred to as product No. 065MLPV60U (or "P-9") obtained from Fiberweb, North America of Washougal, WA. The underlying layer of the laminate (or "tertiary topsheet") 48 preferably comprises a multi-bonded air laid nonwoven material that is thermally bonded using powder bonding and latex bonding. In a preferred embodiment, this multi-bonded air laid nonwoven material comprises about 77% cellulose fibers, about 20% powder binder, and about 3% latex binder (1.5% sprayed on each side of the web) and has a basis weight of about 50 g/yd^2 (about 60 g/m^2). (Unless otherwise stated, all percentages herein are by weight.) Such a multi-bonded air laid nonwoven is preferably obtained

as product No. 90830X312 from Merfin Hygienic Products, Ltd. of Delta, British Columbia, Canada. These two nonwoven layers are preferably laminated together by depositing the multi-bonded air laid nonwoven material on the spunbonded polypropylene nonwoven material. The spunbonded material is used as a process aid or carrier web in the process of forming this laminate.

In alternative embodiments, the spunbonded polypropylene nonwoven material may have a greater or a lower basis weight, or it may be replaced by an air laid tissue, a wet laid tissue, or any of the materials described above. If a wet laid tissue is used instead of a polypropylene nonwoven material, the orientation of the laminate is preferably reversed so that in the finished product, the multi-bonded air laid nonwoven material lies above the wet laid tissue layer. In the case of thicker sanitary napkins, any of the acquisition components described above can be used. Additionally, in one preferred thicker sanitary napkin embodiment, a low density latex bonded air laid material can be used as the entire acquisition component (that is, no tertiary topsheet is required). A low density latex bonded air laid material suitable for this purpose is a material having a basis weight of about 80 g/m^2 known as product No. FG413MHB, which is obtained from Walkisoft, USA of Mt. Holly, NC.

The topsheet 38 described herein is preferably fused to the acquisition component 44 or to the absorbent core 42, or to both. A suitable manner for fusing (or integrating) the topsheet to underlying components at discrete sites is described in the aforementioned US Patent Application Serial No. 09/074,909. As described in the above-referenced applications, the bonding of the topsheet to underlying layers is preferably done at discrete locations and the center of the article is provided with an "un-bonded window."

<u>Assembly of the Sanitary Napkin</u>

The topsheet 38, the acquisition component 44, if included, the backsheet 40, and the absorbent core 42 may be assembled in a variety of configurations known in the art (including layered or "sandwich" configurations and wrapped or "tube" configurations). Figures 1 and 2 show a preferred embodiment of the sanitary napkin 20 assembled in a sandwich construction. In Figures 1–3, the topsheet 38 and the backsheet 40 have length and width dimensions generally larger than those of the absorbent core 42. The topsheet 38 and the backsheet 40 extend beyond the edges of the absorbent core 42 to form portions of the periphery 30. The garment-facing side of the topsheet 38 is preferably joined to the body-facing side of the acquisition component 44 as described above. The acquisition component 44 may be joined to the absorbent core 42, if desired. If these components are joined, they can be joined in any of the manners described herein

for joining the topsheet 38 to the acquisition component 44. However, in the embodiment shown in the drawings, the acquisition component 44 is not directly joined to the absorbent core 42. The backsheet 40 is preferably joined to the garment-facing side of the absorbent core by adhesives.

The portions of the topsheet 38 and backsheet 40 that extend beyond the edges of the absorbent core 42 and the acquisition component 44 are preferably also joined to each other. These portions of the topsheet 38 and backsheet 40 can be joined in any suitable manner known in the art. The term "joined", as used in this specification, encompasses configurations in which an element is directly secured to another element by affixing the element directly to the other element; configurations in which the element is indirectly secured to the other element by affixing the element to intermediate member(s) which in turn are affixed to the other element; and configurations in which one element is integral with another element, i.e., one element is essentially part of the other element. Preferably, in the embodiment shown, these portions of the topsheet 38 and backsheet 40 are joined using adhesives over substantially the entire portions that extend beyond the edges of the absorbent core 42 and a crimp seal at the end edges 28 of the main body portion where the topsheet 38 and backsheet 40 are densified by the application of pressure or heat and pressure.

Exemplary Absorbent Article Structure

One particularly preferred embodiment of the present invention comprises a topsheet according to the aforementioned US Patent 6,025,049 and the particularly preferred core described above. The performance of this particularly preferred structure is shown as Sample 2 in Table 1 below. As can be seen in the data presented in Table 1, this particularly preferred embodiment has a very desirable balance of fluid handling properties and softness.

In particular, the topsheet 38 of this particularly preferred embodiment comprises a formed thermoplastic film having a plurality of macroapertures that allow fluids contacting the body surface of the topsheet 38 to pass therethrough and a multiplicity of microapertures that extend upward and form the body contacting surface 20A when the formed film is used as a topsheet. The land area between the microapertures and the macroapertures is also provided with a plurality of microscopic, discontinuous, spaced regions that comprise depositions of a low surface energy material. There is a surface energy gradient between the depositions and the underlying polymeric structure of the particularly preferred topsheet 38 that creates a force which encourages bodily fluids deposited on the body surface 20A to move to the macroapertures and therethrough for absorption by the core 42.

This preferred embodiment also comprises an acquisition component 44 which underlies the topsheet 38 as described above. A acquisition component 44 comprises secondary topsheet 46 of spunbonded polypropylene nonwoven material and a tertiary topsheet 48 of a multi-bonded air laid nonwoven material that is thermally bonded using powder bonding and latex bonding as is described above and in the aforementioned US Patent 5,549,589.

The core 42 for this preferred embodiment is described in detail above and in greater detail in commonly assigned, copending US Patent Application serial No. 60/128,352, filed in the name of Noel, et al on April 8, 1999. As noted above, these preferred structures for core 42 comprise blends of hardwood and softwood fibers that provide high capillary pressure and superabsorbent polymers that provide a high osmotic storage capability.

The preferred components discussed above, along with a liquid impervious backsheet 40 as may be known to the art are assembled into a preferred embodiment of the sanitary napkin 20 of the present invention according to the configuration discussed in the Assembly of the Sanitary Napkin section above

Optional Components

Flaps

The sanitary napkin 20 shown in Figures 1-2, as discussed above, preferably comprises an optional pair of flaps 24 that are joined to the main body portion 22. The flaps 24 extend laterally outward beyond the longitudinal side edges 26 of the main body portion 22 from their proximal edges 60 to their distal edges (or "free end") 62. The flaps 24 extend outward from at least the central region 36 of the main body portion 22. As shown in Figure 1, each flap 24 is divided into a front half 64, and a back half 66 by a flap transverse centerline T_1. The flap transverse centerline T_1 may coincide with the principal transverse centerline T of the sanitary napkin, but this is not absolutely required.

The flaps 24 can be joined to the main body portion 22 in any suitable manner. Preferably, in the embodiment shown in Figures 1-3, the flaps 24 are integral with the main body portion 22 (that is, the flaps 24 comprise integral extensions of the topsheet 38 and backsheet 40). In other alternative embodiments, the flaps 24 can comprise separate components that are joined to the main body portion 22. The flaps 24 are each joined to (or associated with) main body portion 22 along a juncture. This is typically a longitudinally-oriented (or "longitudinal") juncture, such as lines of juncture 68. As used herein, the terms "juncture" (or "line of juncture") refer to regions where the flaps 24 extend from or are joined to the main body portion 22. The line of juncture 68

in the embodiment illustrated in the drawings can be considered to be defined by concave inwardly-oriented regions or lines.

The flaps 24 can be in any suitable configuration. Suitable flaps are described in Reexamined Patent No. B1 4,589,876, issued to Van Tilburg, Certificate of Reexamination issued April 27, 1993; US Patent 4,687,478, which issued to Van Tilburg on August 18, 1987; US Patent 5,389,094 issued to Lavash, et al. on February 14, 1995; US Patent 5,558,663 issued to Weinberger, et al. on September 24, 1996 (which describes an alternative to flaps that are applied by the wearer); and in International Patent Application Serial No. PCT US 96/15957 filed on October 3, 1996, in the name of Lash, et al. Other preferred features for the flaps 24 including a deformed region that forms a hinge and zones of extensibility or zones of differential extensibility are described in US Patent Application Serial No. 09/074,909 filed on May 8, 1998, in the name of Daniels et al. and International Patent Application Serial No. PCT/US96/2087, filed on December 20, 1996, in the name of Lynard et al., which application designates the United States.

Attachment Means

The garment surface 20B of the sanitary napkin 20 may include, and preferably does include, fasteners for attaching the sanitary napkin to the wearer's undergarment. Figure 3 shows the central pad fastener 82 which is adapted to secure the main body portion 22 of the sanitary napkin to the crotch region of an undergarment. Any types of fasteners known in the art, such as adhesive fasteners and mechanical fasteners can be used. Fasteners comprising adhesives have been found to work well for this purpose, with pressure-sensitive adhesives being preferred. In a preferred embodiment, the central pad fastener 82 comprises a pair of spaced apart longitudinally-oriented strips or zones of adhesive that are centered about the longitudinal centerline L.

The outer surface of the flaps 24, adjacent the distal edges 62 of the flaps, is preferably provided with a flap adhesive 84. The flap adhesive 84 is used to assist in maintaining the flaps 24 in position after they are wrapped around the edge of the crotch portion of the panty. Suitable adhesive fasteners are described in greater detail in US Patent 4,917,697. The flaps 24 can be maintained in position by attaching the flaps 24 to the undergarment, or to the opposing flap.

The fasteners used with the present invention are not limited to adhesive attachment means. Any type of fastener used in the art can be used for such purpose. For example, the sanitary napkin 20 could be secured to the wearer's undergarment by mechanical fasteners, such as VELCRO, or the fasteners described in US Patent 4,946,527 issued to Battrell on August 7, 1990, or US Patent 5,392,498 issued to Goulait, et al. on February 28, 1995. For simplicity, however, the fasteners will be described in terms of adhesive attachment means.

The adhesive attachment means are respectively covered by removable release liners, central pad release liner and flap release liner, both designated 86. The pressure-sensitive adhesives should be covered with release liners 86 to keep the adhesives from sticking to extraneous surfaces prior to use. Suitable release liners are described in US Patent 4,917,697. A particularly preferred release liner which also serves as an individual package for wrapping the sanitary napkin is described in US Patent 4,556,146 issued to Swanson, et al.

The sanitary napkin 20 of the present invention is utilized by removing the release liners 86 and placing the sanitary napkin 20 in a panty. The main body portion 22 is placed in the crotch portion of the panty with one end of the main body portion 22 extending towards the front section of the panty and the other end towards the back section of the panty. The backsheet 40 is placed in contact with the inner surface of the center of the crotch portion of the panty. The central pad adhesive fastener 82 maintains main body portion 22 in position. The distal portions of the flaps 24 are folded around the side edges of the panty. The flap adhesives 84 secure the flaps 24 to the underside of the panty or to the opposing flap.

EXAMPLES

Example 1.

This example compares fluid handling and softness, as evaluated according to the methods given in the ANALYTICAL METHODS section below, of various embodiments of a sanitary napkin form of the present invention with exemplary prior art sanitary napkins and commercially available sanitary napkins that are believed to represent best in class of the prior art.

Table 1

Sample No.	Strikethrough (Seconds)	Wetback (Milligrams)	Drop Acquisition (Seconds)	Softness (PSU)
1	43	45	3	34
2	47	9	5	35
3	10	5	5	37
4	13	5	6	8
5	95	11	25	31
6	55	11	6	9
7	195	330	0.2	49
8	33	749	18	49
9	38	8	8	8
10	134	19	0.2	22

11	11	4	0.3	5
12	49	43	49	41
13	63	6	52	36
14	60	46	3	38
15	55	28	0.6	36
16	64	83	47	26
17	71	30	0.5	23

Sample No.	Sample Description
1	Prior Art: topsheet according to US Patent 6,025,049, core according to application Serial No. 09/074,909
2	Present invention: topsheet according to US Patent 6,025,049, particularly preferred core described above
3	Present invention: topsheet according to US Patent 6,025,049, thick, airfelt core
4	Prior art: topsheet according to US Patent 4,342,314, thick, airfelt core
5	Present invention: topsheet according to application Serial No. 09/217,736, particularly preferred core described above
6	Prior art: topsheet according to US Patent 4,342,314, core according to application Serial No. 09/074,909
7	Prior art: A thin sanitary napkin available in Japan from Kao Mfg. Co. as Laurier Softmesh Ultra
8	Prior art: A thick sanitary napkin available in Japan from Kao Mfg. Co. as Laurier Softmesh Slim
9	Prior art: A thin sanitary napkin available in Japan from UniCharm as Sofy Sara
10	Prior art: A thin sanitary napkin available from Personal Products Co. of Skillman, NJ as Stayfree Ultra Thin
11	Prior art: A thick sanitary as available in Venezuela from Johnson & Johnson de Venezuela as Stayfree Alas Normal Malla Siempre Seca
12	Prior art: A thin sanitary napkin as available in Germany from Kimberly-Clark GmbH as Kotex Camelia
13	Prior art: A thin sanitary napkin as is available in Korea from elleair as elis
14	Present Invention: Permanently hydrophilic topsheet according to the aforementioned US Patent application Serial No. _____ (P&G Case 8012 Applicant will add application Serial

No. when known) having a core according to described in US Patent 5,795,921

15 Present Invention: Formed film polyethylene topsheet according to the aforementioned US Patent application Serial No. _____ (P&G Case 8012 Applicant will add application Serial No. when known) having a core according to described in US Patent 5,795,921

16 Prior Art: Hydrophobic nonwoven topsheet available from Corovin GmbH of Penne, Germany as Corolind and apertured so as to have a basis weight of 20 grams/m^2 according US Patent 5,628,097,

<u>Sample No.</u> <u>Sample Description</u>

17 Prior Art: Surfactant treated hydrophobic nonwoven topsheet available from Corovin GmbH of Penne, Germany as Corolind and apertured so as to have a basis weight of 20 grams/m^2 according US Patent 5,628,097

<u>Example 2</u>

This example compares the softness-related properties of topsheets according to the present invention and according to the prior art.

Table 2

Sample No.	Softness (PSU)	Compressibility (g/cubic cm)	Surface Density (g/cubic cm)
1	32	325	0.027
2	4	549	0.037
3	43	581	0.072
4	46	226	0.018
5	–	714	0.050
6	–	592	0.073
7	–	653	0.150
8	–	488	0.058
9	–	205	0.037
10	47	339	–

11	33	430	–
12	48	939	–
13	–	250	–
14	41	350	–

Sample No.	Sample Description
1	Topsheet according to US Patent 6,025,049
2	Topsheet according to US Patent 4,342,314
3	Topsheet according to application Serial No. 09/217,736
4	A nonwoven used as a topsheet on the thin sanitary napkin available in Japan from Kao Mfg. Co. as Laurier Softmesh Ultra
5	A formed film used as a topsheet on the thin sanitary napkin available in Japan from UniCharm. as Sofy Sara
6	A nonwoven used as a topsheet on the thin sanitary napkin available from Personal Products Co. of Skillman, NJ as Stayfree Ultra Thin

Sample No.	Sample Description
7	A formed film used as a topsheet on the thick sanitary napkin as available in Venezuela from Johnson & Johnson de Venezuela as Stayfree Alas Normal Malla Siempre Seca
8	A nonwoven used as a topsheet on the thin sanitary napkin as available in Germany from Kimberly-Clark GmbH as Kotex Camelia
9	A nonwoven used as a topsheet on the thin sanitary napkin as is available in Japan from elleair as elis
10	A formed film polyethylene topsheet according to the aforementioned US Patent application Serial No. _____ (P&G Case 8012 Applicant will add application Serial No. when known)
11	A formed film topsheet according to US Patent 4,629,643
12	A hydrophobic nonwoven nonwoven as is available from Corovin GmbH of Penne, Germany as Corolind that is apertured according US Patent 5,628,097 so as to have a basis weight of 20 grams/m^2

13 A permanently hydrophilic formed film topsheet according to the aforementioned US Patent application Serial No. _____ (P&G Case 8012 Applicant will add application Serial No. when known)

14 A permanently hydrophilic textured, formed film according to the aforementioned US Patent application Serial No. _____ (P&G Case 8011 Applicant will add application Serial No. when known)

ANALYTICAL METHODS

Drop Acquisition Time

1) Place a topsheet sample, approximately 18 cm x 28 cm, over one layer of BOUNTY towel (available from Procter & Gamble of Cincinnati, OH) on a flat surface. Place a clear Lexan® plate, 15 cm long by 20 cm wide by 1 cm thick, with eighteen 1.9 cm (¾") holes drilled 2.5 cm apart in 3 rows of six holes each, on top of the topsheet sample. The pressure exerted on the sample by this plate is ~0.02 psi(0.14 kPa), ensuring intimate contact between the topsheet and the Bounty towel.
Alternatively, if complete products are to be evaluated, the plate is not used. Instead, eighteen drops (see Step 2) are applied to the product sample in a pattern wherein: six drops are applied adjacent the intersection of the longitudinal and lateral centerlines of the product; three drops are applied adjacent each end adjacent the longitudinal centerline; and three drops are applied adjacent each side, adjacent the lateral centerline.

2) Deliver a 45 microliter drop of sheep blood from a pipette (A 100 microliter capacity Eppendorf Air Displacement Pipette has been found to be satisfactory) onto the surface of the sample within one of the holes in the plate. The pipette tip should be approximately 3–5 mm above the topsheet surface, and the drops should be applied in such a manner that the force exerted by delivery from the pipette is minimized.

3) Start timing acquisition as soon as the drop contacts the sample.

4) Stop timing when the top surface plane of the sample again becomes visible as a result of the drop passing into or through the sample. Record this drop acquisition time.

5) If the acquisition time exceeds 60 seconds, record the result as 61 seconds.

6) Repeat steps 1 through 5 an additional seventeen times through the remaining holes in the Lexan plate so as to provide eighteen measurements per sample.

7) Repeat steps 1 through 6 on two more topsheet samples.

8) Calculate the mean drop acquisition time, using 61 seconds for those drops which did not pass into or through the sample within 60 seconds.

Liquid Strike-Through Time

This test method measures the strike-through time, i.e. the time required for a known volume of liquid applied to the body surface of a topsheet material or absorbent article, which is in fluid contact with an underlying absorbent, to pass through the sample. The method used herein is described in European Disposables and Nonwovens Association (Brussels, Belgium) standard method number 150.3-96 with the following differences:

Test Condition	EDANA Method 150.3-96	Method of Present Invention
Environmental Temperature	20±2°C	22±1°C
Relative Humidity	65±2%	50±2%
Test Fluid	Synthetic Urine	Sheep's Blood
Underlying Absorbent	Filter Paper	Finished Absorbent Article
Confining Pressure	500g/(12.5cm)^2(~0.3 kPa)	0.25 psi (1.7 kPa)
Volume of Fluid to Acquire	5ml, one insult	10 ml, one insult

Wetback

Wetback is a test designed to measure the amount of liquid which emerges from an absorbent structure through a topsheet to cause wetness on the surface of the topsheet. The method used herein is described in European Disposables and Nonwovens Association (Brussels,

Belgium) standard method number 151.1-96 with the following differences:

Test Condition	EDANA Method 151.1-96	Method of Present Invention
Environmental Temperature	20±2°C	22±1°C
Environmental Relative Humidity	65±2%	50±2%
Filter Paper Type	ERT FF3	Ahlstrom (Mt. Holly Springs, PA) #632
Number of Pieces of Filter Paper	5	7
Confining Pressure	4000g/(10cm)^2(~3.9 kPa)	0.77 psi (5.2 kPa)
Test Fluid	Synthetic Urine	Sheep's Blood
Fluid Loading	3.3 times wt of filter paper	7.5 ml
Exposure Time:		
Distribution	3 Minutes Under Load	15 Minutes
Rewet	2 Minutes	15 Seconds

Panel Softness

Overview

A trained panel of graders is used to compare the tactile softness of a series of test products or topsheet materials.

Graders

Graders are all female and are selected and trained for ability to discriminate small differences in tactile softness. As part of this training, each grader identifies a "dominate" (i.e. most sensitive) hand which is used in all evaluations. Graders are monitored on a study to study basis and retrained as needed to minimize drift with time.

Apparatus

Sensory Box While a room designed for sensory evaluations having features such as, grader separation from other graders, barrier between sample and panelist which allows sample access through slit, and other features as are known to the art is preferred, the sensory box described hereafter has been found to be suitable for softness evaluations. A 33 cm X 43 cm (face) X 20 cm (deep) rectangular box having an open back for sample presentation and a front opening screened by a black curtain (the curtain is in 2 portions each about 21 centimeters wide and separated in the middle to allow easy grader access).

Felt A 23 cm X 18 cm felt is used as a substrate when topsheet-only samples are graded. A suitable material is 54 Polyester felt, Rainbow Classic, Royal Blue as is available from Kunin Felt of Hampton, NH.

Method

1) The panel moderator introduces the first sample into the sensory box. Up to six test samples may be evaluated in any one test period. Two control samples, one with a relatively high softness reading (a hydroformed film made according to the aforementioned US Patent 4,629,643 ~35) and one with a relatively low softness reading (a formed film made according to the aforementioned US Patent 4,342,314 ~5) are used in each series. Samples are presented to each grader in a random order. When topsheet-only samples are evaluated, the sample is first spread smoothly on the surface of the felt before presentation to the grader. Each sample is only graded one time.

2) The grader grades each sample using a 60 point scale for softness where, for softness, 0 is identified as not soft at all and 60 is identified as very soft/fluffy. The grader uses the finger tips of the first three fingers of her dominant hand to determine a softness grade for the sample (the fingers are arched so only the tips contact the sample). The control samples are used to maintain consistency between tests. The grade for each sample is recorded by marking the grade on a linear scale on the sample data sheet.

3) Steps 1 and 2 are repeated for a minimum of 12 graders.

Report

Report the mean and standard deviation for each sample tested, including the control samples. Known methods of determining statistically significant differences (e. g. analysis of variance, Newman-Keuls Multiple Range Test, etc.) may be used.

Thickness Under Load

Overview:

This test procedure determines material thickness as a function of applied load. Data generated using this procedure can be used to calculate compressibility and surface density as functions of applied load.

Scope:

This procedure applies to materials from 0.2 mm to 5 mm thick. Samples tested by this procedure should be flat and not have significant curvature. Top and bottom surfaces of the material should be essentially parallel.

Sampling:

Samples should be cut such that they are larger than the 25.4 mm diameter platen used to compress the sample. A rectangular cutting die 3.81 cm by 6.99 cm is suitable. The area to be tested must be able to lie flat. Samples may be cut from individual materials or finished products but the cut area must be free from wrinkles or curvature and the sampling procedure should not distort the dimensions of the material. For example, when sampling finished products, the sample material must be cleanly separable from other materials. At least three different samples should be measured with the average result reported.

Apparatus:

Use a constant rate of extension (CRE) tester. A suitable CRE tester is the Instron Model 5564, available from the Instron Corporation, Canton, MA. The CRE tester must have accurate control and measurement of crosshead position to 0.01mm. The CRE tester must be able to measure load accuracy to 0.5 gram force (5 mN). The CRE tester should have less than 0.02 mm compliance at 1N applied load. The moving crosshead should be fitted with a 25.4 mm diameter (5.07 cm^2 area) circular, flat platen disk, rigidly attached to the load cell. A circular, flat platen at least 100 mm in diameter should be rigidly fixed to the lower stationary clamp. The faces should be parallel with each other with a tolerance of 0.02 mm or less.

Procedure:

1. The grammage of the topsheet sample should be determined by weighing a precisely known area of 100 cm^2 or larger on an analytical balance to the nearest 0.0002 g.

2. With the parallel platens a known distance apart, the flat sample is placed on the lower platen. For a 1.00 mm thick sample, 3.00 mm is the recommended starting separation. The CRE load cell should be zeroed at the start of each test while the platens are not contacting the sample.

3. The CRE tester lowers the upper platen toward the sample at a rate of 2.54 mm per minute, recording at least 100 data points per mm of travel, until the sample is compressed and a load of 500 grams is reached.

4. The thickness of the material at any given load is determined by the position of the upper platen. Thickness should be measured at a load of 5 grams force and 50 g force, corresponding to 100 Pa and 1000 Pa pressure on the sample.

Calculations:

Compressibility is determined by calculating the secant slope of the stress/strain compression curve between 5g and 50g and dividing this slope by the area compressed. Units for compressibility are grams per cm^3. This slope is calculated by dividing the change in load by the change in thickness. For example, if a material was 1.00 mm thick under a 5g load and compressed to 0.70 mm thick under a 50 g load:

$$\frac{50g-5g}{1.00\ mm - 0.70\ mm} = 150\ g/mm \quad \text{Compression Slope}$$

$$\text{Compressibility} = (150\ g/mm)\ (10mm/cm)\ (1/5.07\ cm^2) = 296\ g/\ cm^3$$

Similarly, surface density at a given load is calculated by dividing the grammage (grams material per square centimeter) by the thickness under the load of interest.

$$\text{Surface Density at X load} = \frac{\text{grammage}}{\text{thickness under X load}}$$

for example, the surface density of a material that has a grammage of 0.00325 grams/cm^2 and a thickness of 0.065 cm at an applied pressure of 100 Pascals is:

$$\frac{0.00325\ grams/cm^2}{0.065\ cm} = 0.0500\ g/cm^3$$

Mean Absorption Pressure

This test measures the height at which the amount of fluid absorbed or desorbed is equal to one half the amount absorbed at a height of 0 centimeters (free absorbent capacity). The method for Capillary Sorption as described in US Patent Application Serial No. 09/258,889 entitled Absorbent Members comprising a High Surface Area Material for Absorbing Body fluids which was filed in the name of Young, et al. on March 1, 1999, was used with the following differences.

1) The initial suction height is 50 centimeters instead of 200 centimeters.

2) The test is conducted at ambient laboratory conditions instead of controlled temperature and relative humidity.

3) The glass frit 202 is not jacketed.

4) The reservoir 206 and the balance 207 are not enclosed.

5) Cylinder 266 and piston 288 are not equilibrated at 31°C.

6) An occlusive film is used instead of an apertured film to minimize evaporation.

7) The set up height is 50 centimeters.

8) There is no evaporation loss correction.

9) The mean capillary absorption pressure is determined from the absorption isotherm as the height where the sample uptake is equal to one half the sample uptake at a height of 0 centimeters.

The disclosures of all patents, patent applications (and any patents which issue thereon, as well as any corresponding published foreign patent applications), and publications mentioned throughout this patent application are hereby incorporated by reference herein. It is expressly not admitted, however, that any of the documents incorporated by reference herein teach or disclose the present invention. It is also expressly not admitted that any of the commercially available materials or products described herein teach or disclose the present invention.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention.